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EXPERIMENTS IN THE TREATMENT OF PLANT DISEASES.

By B. T. GALLOWAY and D. G. FAIRCHILD.

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PART I.

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TREATMENT OF BLACK ROT OF GRAPES.

The present season a series of experiments was made by the writers with a view of determining the value of certain lines of treatment for several destructive plant diseases. The results of this work we propose to set forth in two or three papers which we hope to get into the hands of fruit growers, and others directly interested, before spring. The present paper relates to an experiment made in the treatment of black rot of the grape, at Vienna, Va., 12 miles southwest of Washington.

The vineyard is the property of Capt. J. O. Berry and consists of 1,000 Concord vines sixteen years old trained to stakes 8 feet high. The vines had never been treated for rot, in fact they had been practically abandoned for the past five years on account of this disease. This, together with the fact that there had been little done in the way of pruning or soil cultivation, offered the very best means of thoroughly testing the value of the fungicides.

In the experiments an endeavor was made to throw some light on the following questions:

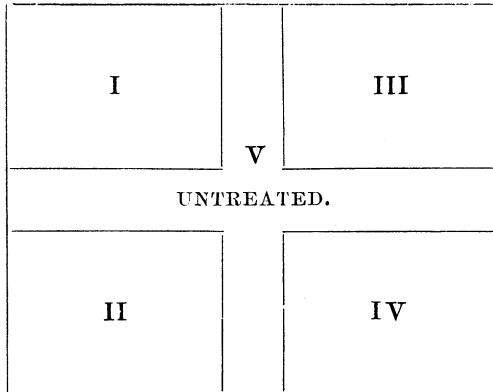
I. The best means of applying the preparations.

II. The relative value of the Bordeaux mixture, ammoniacal copper carbonate solution, copper carbonate in suspension, and a mixed treatment consisting of three applications of the Bordeaux mixture followed by five of the ammoniacal solution.

III. The actual cost of each treatment.

IV. The amount of copper found at the harvest on fruit treated with Bordeaux mixture.

The vineyard was divided into five plats as shown in the accompanying diagram.



Plat I, consisting of 203 vines, was treated with Bordeaux mixture, formula *b*.

Plat II, of 221 vines, treated with ammoniacal solution of copper carbonate.

Plat III, 167 vines, treated with copper carbonate in suspension, 3 ounces to 22 gallons of water.

Plat IV, 183 vines, treated three times with Bordeaux mixture, followed by five applications of the ammoniacal copper carbonate solution.

Plat V, 179 vines, no treatment.

All of the plats received eight sprayings, the first on May 1, and the rest, excepting the last, at intervals of fifteen days. The last spraying, on account of dry weather, was prolonged to 20 days.

Plats I to IV, inclusive, were of practically the same area, but owing to removals of dead vines an actual count revealed the number for each division to be as given above.

Of the various plats it may be said that early in the work it was observed that Plat I was made up of superior, and Plat III of inferior vines. Hence it was not expected that there would be entire uniformity in the yield of the various divisions even if the treatment for all had been the same. The pruning for 1890 was done in March, and at the same time the weeds, grass, and old berries were plowed under. This work was rather hastily done, as could be seen from the quantities of debris lying about under the vines even as late as the middle of April.

*Applying the Remedies.*—In this work three spraying machines were tried, namely, the Eureka, manufactured by Adam Weaber, of Vineland, N. J.; the Japy, made for us by the Columbia Brass Works, of Washington, D. C., and a Little Giant machine manufactured by the

Nixon Nozzle and Machine Company, of Dayton, Ohio. The Eureka and Japy are knapsack pumps, each holding about 4 gallons. The Little Giant is a cart machine holding 40 gallons and is designed to be drawn by hand. After a careful test of all the machines the Little Giant was selected as the one best adapted to our wants. It was provided with 16 feet of hose, and owing to the manner in which the vines were trained this enabled us to treat 4 rows at a time. There is no doubt that the knapsack pumps are less wasteful than the Nixon machine, and when arrangements can be made for properly filling them without loss of time they will doubtless be found as effectual and economical for reasonably small vineyards as any pumps now in use. Of course, for large vineyards one should have a machine capable of utilizing horse power. Throughout the experiments we used the Improved Vermorel nozzle and lance, which has already been figured and described in the published reports of this Division.\*

*Relative value of the treatments.*—During the entire work an endeavor was made to have the conditions for all the plats as nearly alike as possible, in order that at the harvest the percentage showing the relative value of the treatments might be obtained. For reasons already given the total yields for the various plats were not to be relied upon, hence the following plan was adopted for determining the effects of the sprayings.

On July 30, when it was evident that no further changes due to the disease would occur in the fruit, the different plats were carefully examined and every bunch counted. As the counting proceeded the bunches were divided into two classes, namely, diseased and healthy. Every bunch showing five or more diseased berries was classed as diseased, while all bunches having less than five diseased berries were counted healthy. Assuming that all of the diseased bunches were *lost*, we were able by a single calculation to get the percentage of fruit saved for each plat. A comparison of these percentages shows the value of the various treatments. The only source of error in such a calculation is that some of the treated bunches might have become diseased and dropped from the vines before the count was made. This would have been serious had it not been carefully noted, at frequent intervals during the entire work, that the treated sections scarcely lost a berry.

Below are given the results of the count as above described :

PLAT I.

Treated with Bordeaux mixture.

Number of vines.....	203
Total number of bunches .....	2,289
Number of diseased bunches.....	19
Number of healthy bunches.....	2,270
Per cent. saved.....	99.2

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\* Journal of Mycology, vol. 6, No. ii, p. 57. Circular No. 8.

## PLAT II.

Treated with the ammoniacal copper carbonate solution.

Number of vines.....	221
Total number of bunches.....	3, 135
Number of diseased bunches.....	80
Number of healthy bunches.....	3, 055
Per cent. saved.....	97.5

## PLAT III.

Treated with copper carbonate in suspension.

Number of vines.....	167
Total number of bunches.....	708
Number of diseased bunches.....	45
Number of healthy bunches.....	663
Per cent. saved.....	93.64

## PLAT IV.

Treated three times with the Bordeaux mixture, followed by five applications of the ammoniacal copper carbonate solution.

Number of vines.....	186
Total number of bunches.....	1, 866
Number of diseased bunches.....	51
Number of healthy bunches.....	1, 815
Per cent. saved.....	97.27

## PLAT V.

No treatment.

In this plat, consisting of 179 vines, every bunch was diseased, so that according to the classification adopted the loss was total. By the 21st of July the majority of the bunches had fallen. On the 30th, however, it was thought best to count all bunches which had two or more healthy berries upon them. As a result of this count it was found that the yield was 170 bunches, none of which were fit for market.

Bringing together now the several percentages of fruit saved we have for—

Bordeaux mixture.....	99.20
Ammoniacal copper carbonate solution.....	97.50
Copper carbonate in suspension.....	93.64
Bordeaux mixture and ammoniacal copper carbonate solution.....	97.27
Untreated.....	00.00

*Cost of the various treatments.*—The total cost of treating each plat, estimating the labor at 15 cents an hour, was as follows:

## PLAT I.—203 vines.

Bordeaux mixture.

210 gallons of mixture.....	\$4. 41
14 hours labor.....	2. 10
Total.....	6. 51
	Cents.
Cost per vine.....	3. 2
Cost per pound of fruit.....	1. 2

PLAT II.—221 *vines*.

## Ammoniacal copper carbonate solution.

196 gallons of solution .....	\$1. 47
12½ hours labor .....	1. 85
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Total .....	3. 32
	Cents.
Cost per vine .....	1. 50
Cost per pound of fruit .....	. 77

PLAT III.—167 *vines*.

## Copper carbonate in suspension.

147 gallons of solution .....	\$0. 75
10 hours labor .....	1. 50
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Total .....	2. 25
	Cents.
Cost per vine .....	1. 35
Cost per pound of fruit .....	2. 08

PLAT IV.—186 *vines*.

## Bordeaux mixture and ammoniacal solution.

302 gallons of mixture and solution .....	\$3. 84
10 hours labor .....	1. 50
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Total .....	5. 34
	Cents.
Cost per vine .....	2. 87
Cost per pound of fruit .....	1. 64

The total yield in pounds of the various plats was approximately as follows:

	Pounds.
Plat I .....	540
Plat II .....	432
Plat III .....	108
Plat IV .....	324
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Total .....	1, 404

The fruit was sold on the vines for 6 cents per pound, making the revenue from each plat as follows:

Plat I .....	\$32. 40
Plat II .....	25. 92
Plat III .....	6. 48
Plat IV .....	19. 44
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Total .....	84. 24

It will be seen by comparing these figures with those giving the total cost of the various treatments, that for Plat I, treated with Bordeaux mixture there was saved \$32.40 worth of fruit at an expenditure of \$6.51, leaving a profit of \$25.89, or 397 per cent.

For Plat II, treated with ammoniacal copper carbonate solution, there was saved \$25.92 worth of fruit at a cost of \$4.32, leaving a profit of \$21.60, or 500 per cent.

For Plat III, treated with copper carbonate in suspension, the value of the fruit saved was \$6.48, the cost of treatment \$2.25, leaving a profit of \$4.23, or 188 per cent.

For Plat IV, treated with Bordeaux mixture and ammoniacal solution, the value of the fruit saved was \$19.44, the expense of treatment \$3.34, leaving a profit of \$16.10, or 482 per cent. A further study of these figures, together with those already given, brings out a number of interesting points, chief of which may be mentioned the following:

I. That while the amount of fruit saved by the Bordeaux mixture was greater than that by the ammoniacal solution the latter preparation is, after all, the cheapest. In other words, there was more profit in using the ammoniacal solution than the Bordeaux mixture.

II. A mixed treatment consisting of Bordeaux mixture and ammoniacal solution is more profitable than a treatment of Bordeaux mixture alone, but not as profitable as the ammoniacal solution alone.

III. There is nothing whatever to be gained by treating with the copper carbonate in suspension when the ammonical solution is at hand.

#### COPPER ON THE FRUIT AT THE TIME OF HARVEST.

The question has often been asked whether there is any danger to be apprehended from eating grapes which have been sprayed with the Bordeaux mixture and other copper solutions.

To obtain some information in regard to this matter representative bunches were taken from Plat I, which was sprayed eight times with Bordeaux mixture.

The last spraying was made on these vines July 30, and between that date and August 28, the day of harvest, only a few slight rains had fallen. The fruit showed the mixture plainly, more pronouncedly in fact than any treated grapes seen in the market. One kilogram of the clusters ( $2\frac{1}{8}$  pounds), including the stems, which appeared to have the greater part of the copper, was weighed out, dried, and analyzed.\* As a result of this analysis 1 kilogram of the fruit yielded .005 grammes (.077 grain) of metallic copper. On this basis every pound of grapes treated with Bordeaux mixture contained  $\frac{3.5}{1000}$  of a grain of copper. An adult can take from 8 to 12 grains of this salt without fear of serious results, and to get this amount from sprayed grapes he would have to eat from a ton to a ton and a half of fruit.

According to M. Fallot† the minimum amount of copper introduced into the human system daily through the food is 1 milligram, a trifle less

\* The charring of the clusters was performed at the Department, but the analysis was kindly made by Dr. R. C. Kedzie, Mich. Ag. College.

† Progrés Agricole et Viticole, June 16, 1890. Bull. 11, Sect. Veg. Pathology, p. 100.

than one-half of that necessarily taken with each pound of grapes, stems and all, sprayed as profusely as those analyzed.

When it is considered that 203 vines received in one season's treatment only 57.25 pounds of copper, or  $4\frac{1}{2}$  ounces per vine, the very inconsiderable amount which remains adherent to the berries is not to be wondered at. Although spraying after the middle of July with the Bordeaux mixture is to be avoided, it will be seen that there is no real danger arising therefrom, and when the ammoniacal solution is substituted for the last three sprayings, since it contains only  $\frac{1}{32}$  as much copper, there can be no possible danger.

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#### DISEASES OF THE GRAPE IN WESTERN NEW YORK.

Numerous complaints having been received from correspondents in various parts of western New York of a disease which was seriously injuring grape vines, it was decided to send some one into the field to investigate the matter. Accordingly, on October 18, Mr. D. G. Fairchild was directed to visit Lockport, N. Y., and such other points within the State as might be necessary, and to obtain such information and make such investigations as would enable him, if possible, to determine the cause of the trouble and suggest a remedy therefor. Below is Mr. Fairchild's report.

B. T. GALLOWAY,  
*Chief of Division.*

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WASHINGTON, D. C., *October 25, 1890.*

SIR: In accordance with your instructions, I left Washington on October 18, proceeding directly to Lockport, N. Y., where, through the kindness of the Niagara White Grape Company, I was enabled to obtain much valuable information relative to the new disease of the grape, which is generally referred to under the name of "blight" or "rust." After leaving Lockport several important grape-growing regions were visited, in all of which the new trouble was found more or less abundantly. I submit my report on the investigations made, and also add some notes on other vine diseases which came under my observation.

Respectfully,

D. G. FAIRCHILD,  
*Assistant.*